Sacramento Valley Field Crops Newsletter

Issue 9 August, 2021

University of California
Agriculture and Natural Resources | Cooperative Extension

In This Issue

Submitted by:

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UC Dry Bean Field Day

Honey Bee Haven, UC Davis, Bee Biology Road (38.537080, -121.787661), Davis, CA
Tuesday, August 31st ~ 9:00am-11:30am

This event is free to attend! - - CCA credits pending (2 hours)
Pre-registration is required: https://tinyurl.com/ucbean21

9:00 am General Introduction
Paul Gepts, UC Davis

Improving Both Productivity and Nutritional Quality in Beans
Christine Diepenbrock, UC Davis

Garbanzo Drought Tolerance Genetic Study
Claire Spickermann, UC Davis

Applying Novel Sensor Technology to Studying Lygus Interactions in Lima Bean
Kimberly Gibson, UC Davis

Green cotyledon and Growth Vigor Research
Varma Penmetsa, UC Davis

Lima Bean Breeding and Cooperative Dry Bean Nursery
Antonia Palkovic, UC Davis

Dry Bean Research Update: Seed Treatments, Plant Growth Regulators, USDA Garbanzo Variety Trials - *Rachael Long, UC Cooperative Extension*

Nitrogen Fertility in Common Beans following Whole Orchard Recycling
Michelle Leinfelder-Miles, UC Cooperative Extension

10:30 am ***Travel to Agronomy Field Headquarters***

Release of New Bean Varieties with Heirloom-like Seed Patterns, BCMV Resistance, and Improved Yields - *Travis Parker, UC Davis*

Post-emergence Herbicide Options for Broadleaf Weed Control in Blackeye-beans
Jose Luiz Carvalho de Souza Dias, UC Cooperative Extension

UC Blackeye Variety Trial Updates
Sarah Light, UC Cooperative Extension

11:15 am ***Travel to Campbell Tract Field***

Physiological Breeding for Drought Resilience in Common Bean
Tom Buckley, UC Davis

Pre-plant weed management followed by in-season control improved alfalfa stand and yield

Sarah Light, Agronomy Advisor, UCCE Sutter-Yuba

Background:

Good stand establishment is critical for productivity of an alfalfa field both in year one, and in subsequent years. Weed competition during stand establishment may be irreversible because it can reduce alfalfa root growth, and lead to thinner alfalfa stands and lower forage quality. Thus, it is important to have good weed control during alfalfa stand establishment.

This project evaluated the efficacy of weed control options for both conventional and organic growers. Pre-plant mechanical cultivation or *Glyphosate* spray were evaluated with the goal of providing regionally relevant information about an integrated weed management tool for improved stand establishment.

<u>Methods</u>

Experimental Design:

Table 1. Experimental treatments

Treatment number	Pre-plant treatment	In-season treatment	Herbicide rate(s)
1	None	None	N/A
2	Tillage	None	N/A
3	Glyphosate	None	3 pt/acre
4	None	Raptor	6 fl oz/acre
5	Tillage	Raptor	6 fl oz/acre
6	Glyphosate	Raptor	3 pt/acre + 6 fl oz/acre

Six treatments (Table 1) were replicated three times in the field. Main plots were a pre-plant treatment (either no pre-plant treatment, pre-plant tillage, or pre-plant Glyphosate). Additionally, half of the plots received later in-season treatment (Table 1); either no treatment or Raptor application in-season after the crop had emerged.

This field was planted in the spring in the Sacramento Valley of California. Weeds were germinated with winter rains. On some plots (treatments 3 and 6), Pre-plant Glyphosate was sprayed on plots on 1/31/20 at a rate of 3 pints Glyphosate/acre. On other plots (treatments 2 and 5), mechanical cultivation was implemented on 2/11/20, once the soil was dry enough. This cultivation was very shallow, in the top few inches of the soil, to avoid bringing new weed seeds to the soil surface.

Alfalfa seed was flown on the field on 3/4/20 and the field was then ring-rolled to cover seed and get good seed-to-soil contact. Field was then irrigated for germination a week later. In-season weeds were controlled on some of the plots (treatments 4, 5, and 6) with a tank mix of Raptor (Imazamox Ammonium Salt) at 6 fl oz per acre and Buctril (Bromoxnil) on 4/25/20.

Data Collected: Baseline weed counts were taken on 1/29/20 from all plots before treatment implementation but after weed germination. Individual broadleaf weeds and grasses + sedges were counted in three random 20x20 cm quadrats per plot. Plants were counted on this date because weeds and alfalfa plants were small and percent cover would not have captured potential differences.

Weed counts were taken an additional three times between planting and first cutting from all plots. In season weed counts were taken as percent cover, in which the area of the quadrat was broken up in percent covered with broadleaves, grasses + sedges, bare soil, and alfalfa. On 4/9/20 and 5/14/20, weed counts were taken in three random 20x20 cm quadrats per plot and on 6/8/20 percent cover was observed in 3 random square meter quadrats per plot. The larger quadrat was used for percent cover on 6/8/20 because alfalfa and weeds were tall at this time and the meter by meter square allowed for more accurate representation of each plot.

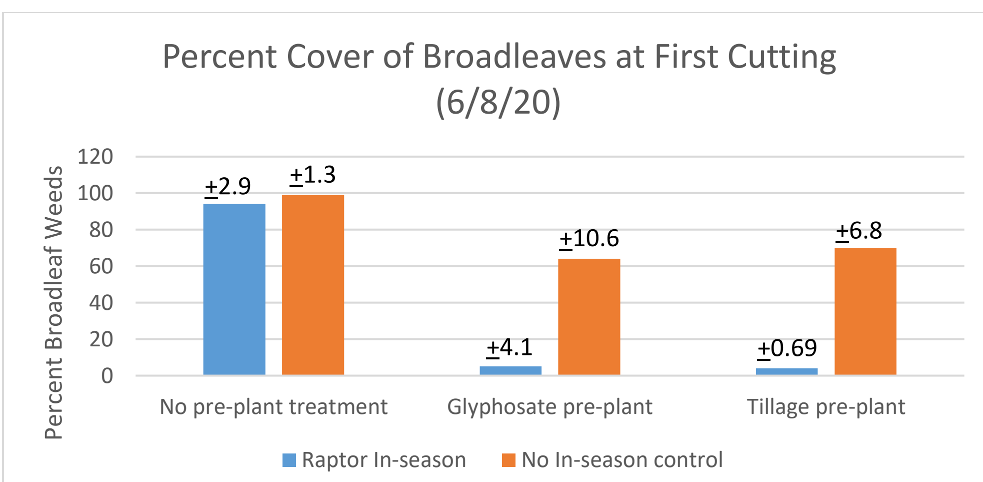
Plots were hand harvested on 6/8/20 prior to first cutting by the grower, which occurred on 6/10/20. Two square meter areas of each plot, which were representative of the larger plot, were cut. Yield biomass was separated into weeds and alfalfa, dried, weighed separately, and then converted to a pounds dry matter/acre basis.

Finally, on 6/23/20 following first cutting, alfalfa stand counts were taken in all plots by counting the number of alfalfa plants in three 20x20 cm quadrats.

RESULTS

Baseline and early weed counts. The first weed counts (1/29/20) collected before treatment implementation showed the average count for grasses + sedges for all plots was zero at this count. For broadleaves, there were no significant differences by treatment but there were significantly more weeds in the side of the field with no in-season control compared to the side where Raptor was applied in-season. **4/9/20 Weed Counts.** *Grasses + sedges:* There were not many grasses or sedges in the field. *Broadleaves:* There were significantly less broadleaves in the plots that had pre-plant weed control (Glyphosate or tillage). *Alfalfa:* Alfalfa plants were small at this counting date however, there were significant treatment differences with the pre-plant weed control treatments having more alfalfa than the control. **5/14/20 Weed Counts.** (Data not shown). *Grasses + sedges:* There were not many grasses or sedges in the field. *Broadleaves:* There were significantly less broadleaves in the plots that had pre-plant weed control (Glyphosate or tillage) and in the plots that had Raptor applied in-season. *Alfalfa:* There was significantly more alfalfa in the plots that had pre-plant weed control (Glyphosate or tillage) and in the plots that had an in-season herbicide.

FIGURE 1: Broadleaf Weed Cover at first harvest as affected by pre-plant and in-season weed control.



Broadleaf Weeds Dominated at first cutting (6/8/20). There were significantly more broadleaf weeds in the plots that had no pre-plant weed control (Glyphosate or tillage) (Figure 1). Additionally, the plots that had Raptor applied in-season reduced broadleaf weeds down to negligible levels compared with no in-season treatment (Figure 1). There were not many grasses or sedges in the field, however, there were more grasses in the side of the field with no in-season herbicide application.

Figure 2. Effect of early weed management and follow-up in-season weed management on percent cover of alfalfa during establishment.

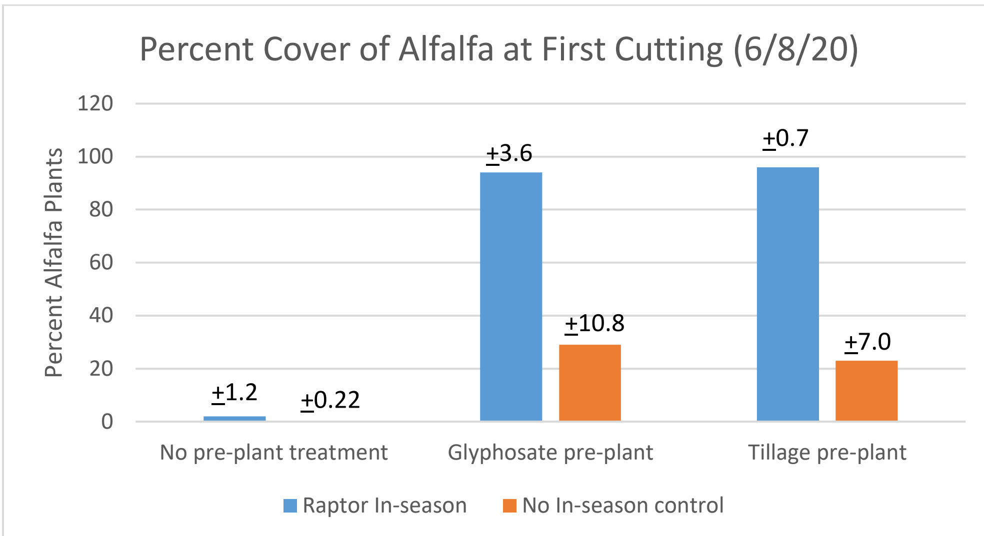
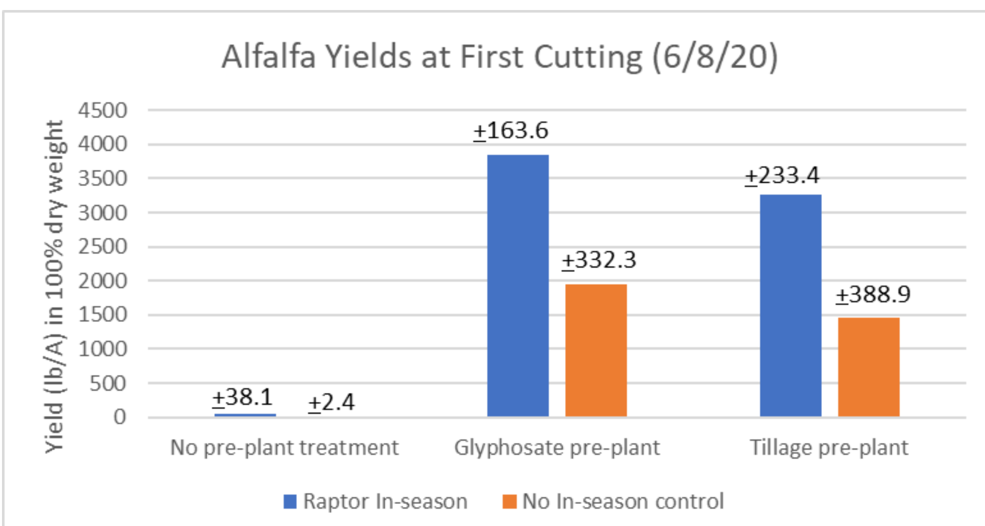


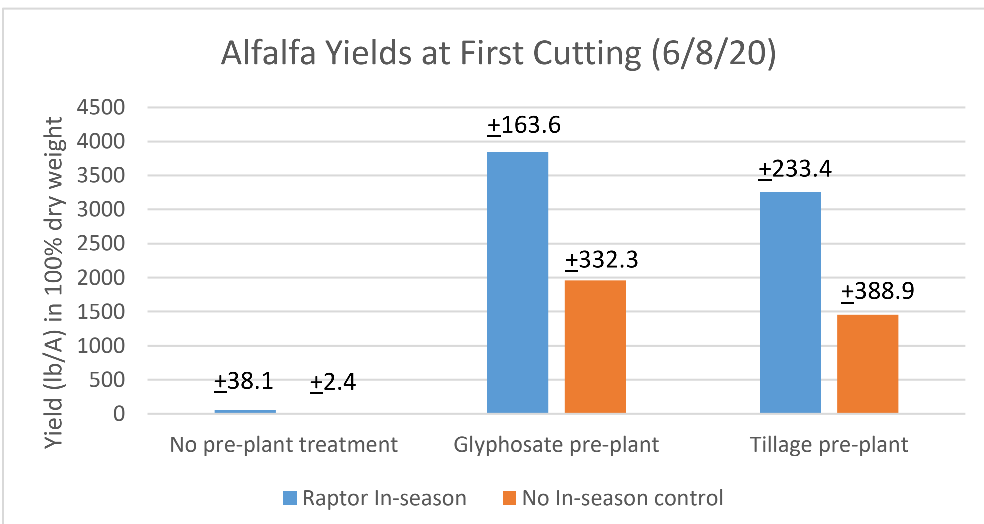
Figure 3. Alfalfa stand counts at first cutting showing significant effects of early pre-plant treatments, as well as the effect of in-season herbicide treatment.



Alfalfa Stand: There was significantly more alfalfa at first cutting in the plots that had pre-plant weed control (Glyphosate or tillage) and in the plots that had an in-season herbicide (Figure 2). Weeds in the no-pre-plant treatment essentially killed many of the young seedlings due to weed competition. This is a key issue, since early growth and establishment of alfalfa seedlings sets the stage for vigorous growth over many years of production. This is demonstrated by the number of alfalfa plants in a 20cm^2 quadrant after first cutting (figure 3). There were significant differences in the alfalfa stand after first cutting. With regard to pre-plant treatments, both Glyphosate spray and tillage pre-plant significantly increased alfalfa stand compared to the plots with no pre-plant treatment.

Example of count data taken after first cutting.

Figure 4. First cut alfalfa yields as affected by early season and in-season weed management.



Alfalfa Yields Were Enhanced by early season and in-season weed management. Alfalfa yields were near zero for the plots where early control was not applied (Figure 4). Additionally, yields were improved over 90% when an in-season weed control was applied (Figure 4). This yield data is only for the first cutting of the stand, not for the full first year of production. There were significant differences in alfalfa yield between pre-plant treatments and plots that had no pre-plant weed control (Figure 4). Both the Glyphosate and tillage pre-plant treatments increased yields. In addition, the Raptor spray significantly increased yields compared to plots without in-season control.

A combination of early weed control combined with in-season weed control was the most successful at controlling weeds and enhancing alfalfa yields.

Biomass was separated into alfalfa and weeds after plots were hand-harvested. Then alfalfa and weeds were weighed separately by plot. There were significantly more weeds, by weight, in the side of the field that did not get the herbicide spray in season compared to the side that did get an herbicide spray. However, within one side of the field (Raptor or not), there were no significant differences by pre-plant treatment. In other words, even though there was more alfalfa in the plots with pre-plant weed control, there were also more weeds. The photos below, taken at harvest show how heavy the weed pressure was even in plots with Glyphosate and tillage pre-plant that did not have in-season herbicide application.

Left: close up of a plot with Glyphosate pre-plant plus in-season Raptor.
Right: close up of a plot with Glyphosate pre-plant but no in-season herbicide.

Below are broad views of the same plots.

When comparing plots with the same pre-plant treatments with or without in-season herbicide spray, plots that were tilled pre-plant did not have significantly different stand counts regardless of in-season herbicide treatment. However, within the plots that were sprayed with Glyphosate pre-plant, those that also were sprayed with Raptor in-season had significantly higher alfalfa stand counts than those that without in-season control.

PROJECT SUMMARY & CONCLUSIONS

The data shows that controlling weeds prior to planting, either with shallow tillage or an herbicide spray (Glyphosate) will reduce weed pressure, increase yields, and lead to a stronger alfalfa stand after first cutting. There were also differences between plots that got an in-season herbicide and those that did not. Yields were highest in plots that had both pre-plant weed control and an in-season herbicide. The plots with the highest stand counts after first cutting were also the plots that had both pre-plant and in-season weed control. However, the stand in the pre-plant treatment plots that did not have in-season herbicide application still had relatively high alfalfa stand counts after first cutting. This means that with early effective weed control, the alfalfa stand may be more robust for future cuttings, even if weed pressure was high initially. As shown in photos above, the alfalfa was robust in the understory of the canopy, even when broadleaf weeds were very large. By first cutting, many broad leaf weeds had gone to flower so likely would not return after first cutting. However, when included in the harvest these weeds reduce quality and price of the hay, and also contribute seed to the weed-seed population in the field.

Ideally, both pre-plant and in-season weed control would be implemented to get highest yields, quality, a vigorous stand, and ensure animal safety. However, growers (particularly organic) may be able to do a pre-plant tillage to control weeds and establish a good alfalfa stand, accept some yield reduction and additional weed pressure leading up to first cutting, and then have a strong alfalfa stand for subsequent cuttings.

Acknowledgments:

Thank you to the California Alfalfa & Forage Association for funding this project. Thank you to River Garden Farms for their collaboration on this project.

Alfalfa Cost of Production Studies

In late 2020, UC Cooperative Extension released two new cost of production studies for establishing and producing alfalfa in California. One is focused on conventional production and the other on organic production. The cost studies can be found on the UC Agricultural Issues Center website: https://coststudies.ucdavis.edu/en/

Sample Costs to Establish and Produce Organic Alfalfa Hay:
https://coststudyfiles.ucdavis.edu/uploads/pub/2021/04/20/alfalfaorganiccadraft42021.pdf

Sample Costs to Establish and Produce Alfalfa Hay:
https://coststudyfiles.ucdavis.edu/uploads/cs_public/02/ee/02ee0710-8c2c-41ea-8b25-736d1854b737/alfalfasvdraft10420.pdf

New Resources Available for Managing Nitrogen in Small Grains Production

There are several new resources available on the UC Cooperative Extension Small Grains Nutrient Management Page: http://smallgrains.ucanr.edu/Nutrient_Management/. Including blog posts on:

- Using Hand-held Electronic Devices to make N Fertilizer Decisions
- Implementing N-Rich Reference Zones to Inform In-Season N Fertilization Practices
- New Resources for Conducting and Interpreting Soil Nitrate Quick Tests

A new online Nitrogen Fertilizer Management Tool for California Wheat

And Case Studies from around the state of California on using the N-Rich Zones to Inform In-Season N Fertilization Practices. The case study from Colusa County is included at the end of this newsletter.

Keep a look out!

Poor control of common chickweed with ALS-inhibitor herbicides reported in South San Joaquin Valley—Is this a new case of herbicide resistance?

There was poor control of common chickweed in several triticale fields in the SSJV reported in early 2021. These fields were treated with ALS-inhibiting herbicides. ALS-resistant common chickweed has been identified in other states. A recent blog posting documents what we know so far about this issue in small grains fields in California: https://tinyurl.com/resistantchickweed

The UCCE Small Grains team is working to confirm if this is herbicide resistance. Early identification of herbicide-resistant weed populations and corresponding changes to management tactics can reduce the spread and establishment of these biotypes. **If you believe you have herbicide-resistant common chickweed populations in your small grains fields and would like to collaborate with us in this project, please complete this online survey: https://arcg.is/1nSCn51 or contact Sarah Light selight@ucanr.edu.**

Using Drones for Summer Worm Control in Alfalfa Hay

Rachael Long, UCCE Yolo County, Dr. Ken Giles, Dr. Xuan Li, Bill Reynolds

Use of drones, UAV unmanned aerial vehicle, for pesticide applications in agricultural crops is increasing and becoming a reality for farm production. Drone technology provides an additional tool to control pests on farms, supplementing traditional ground and aerial spraying practices. This could be especially helpful for applying pesticides on smaller, tough to reach places.

Drone trials, Sacramento Valley, 2020. We compared the performance of a small six-rotor UAV sprayer (PV35) versus a traditional manned airplane for applying insecticides for armyworm and alfalfa caterpillar control in alfalfa hay fields in 2020. These summer worm pests can be highly damaging to alfalfa as the larvae feed on the foliage, causing significant yield and forage quality losses if left uncontrolled. We conducted trials in two alfalfa fields using the insecticide Prevathon (chlorantraniliprole). In each field, one area was sprayed by airplane and the other by drone to compare the efficacy of each application method. Application rates were 10 gallons per acre (gpa) for field site #1 and 5 gpa for field site #2.

Spray cards (water sensitive paper) were placed in the alfalfa canopy prior to spraying to assess spray coverage for both application methods. Plant samples were taken after the fields were sprayed to determine the insecticide residue concentrations on the alfalfa plants. Summer worm and natural enemy counts were taken using a standard sweep net to compare the efficacy of the different spray application methods on pest and beneficial insects.

Drone trial results. The spray cards showed that both drone and airplane insecticide application methods had equivalent spray coverage. The drone application had a bit more variability in terms of spray deposition uniformity than by airplane. This was not due to inherent qualities of the drone, but instead that the drone-based spray technology needs to be fine-tuned. Airplanes have been used for applying pesticides for decades and that technology is refined. Drones are new and there's a bit more work that needs to be done to fine tune them for optimum pest control in crops, such as exploring different nozzle types for best coverage.

There were few differences in the insecticide residue concentrations on the alfalfa plants between the drone and airplane application methods for both 5 and 10 gpa spray rates. Likewise, there were no differences in summer worm counts between the two treatment methods with both drone and airplane applications significantly reducing summer worm counts compared to the untreated control at both 5 gpa and 10 gpa, 3-7 days after treatment, DAT. Prevathon had no impact on natural enemy predators, such as lady beetles, in both application methods

Future of drones in California. Drones are a viable option for aerial application of insecticides for pest control in alfalfa fields. Overall, there were no significant differences in insecticide spray coverage, insecticide residue on plants, and summer worm control between the drone and airplane insecticide application methods. Drones could provide an additional tool for growers to manage pests in their fields. California now has a specific UAV unmanned ag pilot license category which means that the pilot of the drone is not required to have a commercial pilot certificate, only the UAV certificate.

A current limitation for the use of drones for aerial spraying of crops is the 55-pound weight limit mandated by FAA regulations (Federal Aviation Administration) on drone carrying capacity. Some drone companies have obtained certificates for handling more than 55-pounds in California (e.g. Yamaha), helping to pave the way for more people to use drone technology on a larger scale in crop production. However, it could still be a while before the 55-pound weight limit is lifted nationwide for more people to use this technology. This summer we will be investigating ultra-low spray volumes (2.0 gpa) for control of summer worm pests in alfalfa.

Field studies in the Sacramento Valley compared the performance of a small six-rotor UAV drone sprayer versus a traditional manned airplane for applying insecticides for summer worm control in alfalfa hay fields, 2020. (I. Grettenberger, photo credit).

Pests in Hemp

Sarah Light, Agronomy Advisor UC Cooperative Extension

Hemp (*Cannabis sativa*) is an emerging crop in California, with cultivars of industrial hemp legalized for production in the 2018 Farm Bill. By definition, industrial hemp may not contain more than 0.3% of the psychoactive compound THC in the parts of the plants sampled and regulated by the state. Hemp has various end uses ranging from fiber to flower buds to grain seed, however most growers in California are growing hemp for the cannabinoid CBD. Hemp cultivars can be dioecious or monoecious, but hemp cultivars grown for CBD have primarily been dioecious types (male and female flowers on separate plants), with female plants grown for CBD production.

Pests in Hemp:
Since hemp is a new commodity, pest challenges are still being observed and monitored. Certain agricultural pests have been observed on industrial hemp in California, but it is not yet known which cause significant crop damage or yield loss. We know that tobacco budworm and corn earworm can cause severe flower damage. Webworms appear to cause damage to young stands when plants are small, but it is not clear whether hemp plants can grow out of it. Some other known agricultural insect pests have been

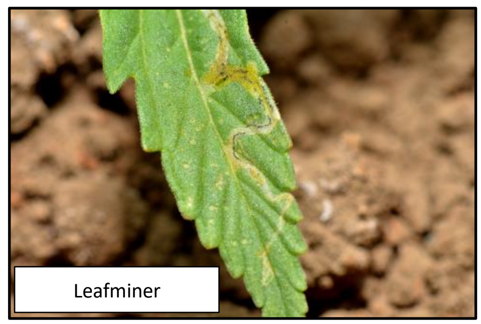
observed on hemp, including leaf miners, spotted cucumber beetle, adult whitefly, lygus, and mites. However, crop loss has not been confirmed for any of these species. While some of these pests can cause visible but minor damage to hemp plants (for example leaf miners), it is not clear if the damage is ever severe enough to affect crop yields. Many beneficial insects like damselflies, native bees, and honeybees have also been seen in these hemp fields.

Examples of common Agricultural pests that have been observed in hemp.
(photos courtesy Ian Grettenberger, UC Davis)


Spotted Cucumber Beetle


Tobacco Budworm


Webworm


Leafminer

Some diseases have also been observed on industrial hemp. Some, like beet curly top virus and Botrytis blight appear to be problematic. Others, like powdery mildew, have been observed but disease pressure was very mild and did not require treatment. Gopher damage to root systems has also been observed in drip irrigated fields. More research is needed to identify important pests of hemp, determine which pests require management, and develop IPM practices. In addition, it is unknown what pest pressure may build up in the landscape in the future as more and more acres of hemp are planted in the state.


Corn earworm cause severe flower damage (photo by S. Light)


Beneficial insects like damselflies have also been seen in these hemp fields. (photo by S. Light)

Managing Pests in Hemp:

Hemp is a highly regulated commodity and regulations are changing to meet industry and environmental safety needs. Talk to your Agricultural Commissioner if you are interested in growing hemp. Pesticides that can be used in hemp are currently limited.

What determines if a pesticide can be used on hemp?
The product must meet three requirements in order to be legal for application on hemp:

- Exempt from residue tolerance requirements
- Exempt from registration
- Use of the product would not be legally considered a use in conflict with the registered label

What does this mean? Basically, a product that is labeled broadly enough to not be excluded from application to hemp can be applied. Generally, these tend to be “softer” chemicals, however, these products still come with risks so care should be taken to follow the label and make safe and effective sprays.

Beet curly top virus (far left) and Botrytis blight (right) can be very problematic in industrial industrial hemp (photos courtesy Bob Hutmacher, UC ANR and Annemiek Schilder, UC ANR)

Bee Safety:

Although most industrial hemp plants are female, the seed feminization process is never 100% true and males will be present in the field. Male hemp plants shed a lot of pollen, making them attractive to native bees and honeybees. Bee Safe practices should be followed when managing pests in hemp. See the project summary on the UCCE Sutter-Yuba Field Crops website:
http://cesutter.ucanr.edu/SacramentoValleyFieldCrops/Project_Summaries/

New UCANR Publication Documenting Herbicide Damage to Hemp is now available:

https://anrcatalog.ucanr.edu/pdf/8689.pdf

Hemp plants were sprayed with low rates of 19 herbicides commonly used in California.

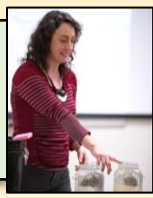
Save the Date!

Western Alfalfa and Forage Symposium

November 16-18, 2021
Grand Sierra Resort, Reno, NV

https://calhaysymposium.com/program/

New Soil Health Connection Episodes online:
https://www.youtube.com/c/TheSoilHealthConnection/videos
Many new episodes of the Soil Health Connection have been posted online including in-field demonstrations of soil health assessments, interviews with farmers about their experiences implementing soil health practices, and information about biochar, biosolids, and grazing on cropland!



E-mail: selight@ucanr.edu
Website: http://cesutter.ucanr.edu/SacramentoValleyFieldCrops/
Instagram: @sacvalleyagronomist
YouTube: The Soil Health Connection

N-Rich Reference Zone Case Study: Colusa County 2019 - 20

Sarah Light, Kim Gallagher, Taylor Nelsen, Mark Lundy

Nitrogen (N) rich reference zones were implemented on a 135 acre wheat field in Colusa County. Average grain yields are approximately 7000 lb/ac. Pre-plant aqua ammonia was shanked in at 60 lb/ac N on 10/30/19. Soil samples were taken after pre-plant fertilization on 11/12/19. The top foot of soil had an average nitrate-N fertilizer equivalent of 66 lb/ac N. Urea was broadcast at 60 lb/ac N with a belly grinder in three 90ft x 180ft N-rich zones on 12/17/19, just prior to a multi-day rainfall event totaling more than 1 in. of precipitation.

Early season conditions: The field was planted about a month later than planned due to heavy early-season rainfall. Seed was flown on at 145 lb/ac. The field was not harrowed after planting due to wet soil conditions. This seeding practice is not common in the area and there was concern over stand establishment. Despite some seed rolling off the beds into the furrows, stand establishment was strong. In mid-February the stand averaged almost 40 plants per square foot. There was heavy weed pressure, including volunteer sunflowers from the previous season, in much of the field. Between planting (12/16/19) and the final in-season assessment on 3/4/20 the crop received 2.3 in. of rainfall and one irrigation (2/24/20-3/7/20) via furrow irrigation totaling approximately 6-7 in. Rainfall during this period was 7.4 in. less than the historical average. The crop was at the mid-tillering stage of growth and approximately 21% of total seasonal N uptake had occurred at this point.

Plant and Soil Measurements: Plant and soil measurements were taken throughout the early vegetative growth stages in order to evaluate whether the crop would respond to additional N fertilizer. These measurements began later than in previous seasons since the field was planted late.

On 2/14/20, soil samples were collected in the top foot of soil from both the N-rich reference zones and the broader field. The samples indicated that approximately 37 lb/ac N fertilizer equivalent nitrate-N remained in the N-rich reference zones and 13 lb/ac in broader field. Canopy reflectance was also measured on 2/14 in both the N-rich reference zones and the surrounding field using a handheld GreenSeeker NDVI meter. These measurements were expressed as a Sufficiency Index (SI). A SI is the ratio of the measurements taken from the broader field to the measurements taken in the N-rich zones. SI values less than 0.97 indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N

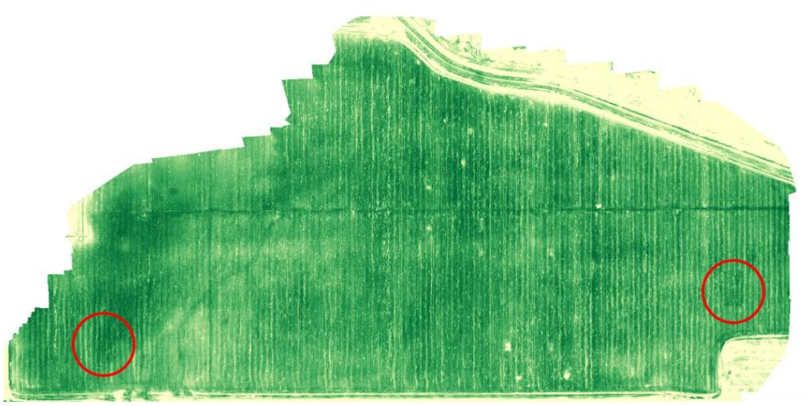


Figure 1. The two N-rich reference zones on the south side of the field were detected on 3/4/20 using drone-based NDRE measurements.

SITE INFORMATION

Location: Colusa County

Soil type: Grandbend loam & Corbiere silt loam

Previous crop: Sunflowers

Variety: Patwin 515HP

Seeding method: Flown on

Seeding rate: 145 lb/ac

Planting date: 12/16/19

Bedded: Yes (60 in.)

Pre-plant N Management

Field rate: 60 lb/ac N

N-rich zone: 120 lb/ac N

N Form: Aqua ammonia (field) + urea (N-rich zones) deficiency. The SI for the two N-rich reference zones in the southern part of the fields was 0.9 on 2/14, while the SI for the northern N-rich reference zone was 1.0. Canopy reflectance (NDRE) was again measured on 2/19 and 3/4/20 using a drone. The average SI from these measurements was slightly higher than the handheld measurements recorded on 2/14. They also indicated possible deficiency in the same two N-rich reference zones in the southern end of the field and no deficiency in the northern N-rich reference zone (Fig 1).

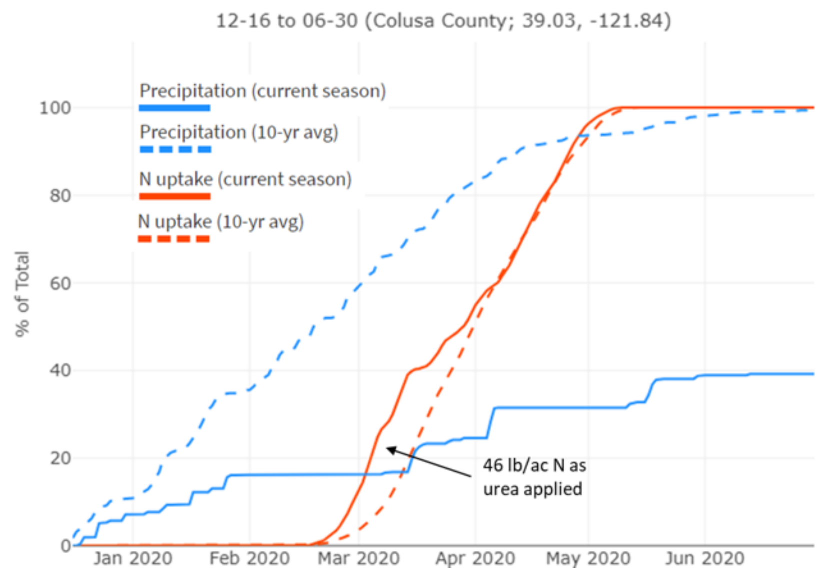


Figure 2. Wheat N uptake (red) and precipitation (blue) as a percent of average annual totals. The solid lines show the 2019-20 season while the dashed lines show the 10-year historical average.

Fertilizer recommendations and in-season management actions: The SI measured from the crop canopy on 2/14, 2/19 and 3/4/20 indicated possible N deficiency in the crop. The low soil nitrate values supported the conclusion that an in-season N fertilizer application would increase yield if it was followed by sufficient rainfall or irrigation to incorporate the fertilizer and meet crop water demand. However, when making an in-season N fertilizer decision, the estimated yield and protein target for the field (5000 lb/ac and 12%) were much lower than normal (7000 lb/ac and 12%). This reflected uncertainty due to a combination of the unconventional seeding method, the droughty early season conditions, the inconsistent deficiency signal between the north and south ends of the field, and early season weed pressure (including volunteer sunflowers). With approximately 90 lb/ac of crop N uptake remaining, the grower chose to fly on 46 lb/ac N as urea on 3/6/20 in advance of a forecasted rain event. During the application, three 15ft x 15ft areas were covered with a tarp to exclude the in-season N fertilizer. These areas were the control areas that allowed the effectiveness of the in-season N application to be measured.

End of season results: The wheat crop yielded 6339 lb/ac with 11.3% protein despite challenging conditions. This was 824 lb/ac higher than the control areas, which did not receive any in-season urea application. Yields were higher in the N-rich reference zones in the southern part of the field as compared to the adjacent bulk field. These differences in yield are consistent with in-season measurements. The two N-rich reference zones in the southern part of the field indicated there was early-season N deficiency, whereas there were no SI or yield differences in the northern part of the field. Overall, the crop removed approximately 157 lb/ac N. This is almost 50 lb/ac N more than was applied. In addition, total N application per acre was 44 lb/ac lower than typical management practices.

OUTCOMES:

- In-season N fertilizer application recommended? Yes
  - 40 - 60 lb/ac N
- In-season N fertilizer applied
  - 46 lb/ac N
- Yield = 6339 lb/ac
  - 1400 lb/ac higher than anticipating
  - 824 lb/ac higher than the control
- Protein = 11.3%
  - 0.7% lower than anticipating
- Crop N removal = 157 lb/ac N
- Total N fertilizer applied = 106 lb/ac N
  - Pre-season: 60 lb/ac N
  - In-season: 46 lb/ac N
  - 44 lb/ac less than grower's typical N rate

There were many in-season challenges including uncertainty around stand establishment, weed pressure, and low seasonal rainfall. In addition, the rainstorm predicted to follow the 3/6 urea application ended up being a drizzle, and there was not a significant rainfall event until 8 days after the urea application. Thus, there were concerns that a portion of the urea might have been volatilized. These challenges meant that there was a risk of lower than normal yield. However, having only applied 60 lb/ac N pre-plant, there was also an opportunity to react to the uncertainty and minimize fertilizer costs. Thus, the grower applied 46 lb/ac N in-season rather than the full 90 lb/ac of crop N uptake remaining to hedge against the uncertain conditions. Rainfall was relatively normal during the second part of the season. In the end, the field achieved close to normal yields in challenging conditions while using less N fertilizer than normal.

Despite many challenges in this field, wheat yield was higher than anticipated. Total crop N removal was almost 50 lb N/ac higher than fertilizer applied.